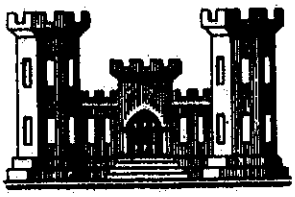
FLOOD CONTROL ALTERNATIVES

FOR THE

NORTH NASHUA RIVER BASIN

MASSACHUSETTS



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

MAY 1979

INTRODUCTION

This booklet was prepared to assist local interests in assessing various alternative solutions to the flood control problems in the North Nashua River Basin. Inasmuch as the principal flood problem is situated along the North Nashua River in the city of Fitchburg, alternatives presented center on solving the problems of this area. All structural plans presented would provide standard project flood (SPF) protection. In addition, because this is a preliminary evaluation of alternatives, estimated of costs and benefits should also be regarded as preliminary.

ALTERNATIVES EVALUATED

STRUCTURAL

Upstream Reservoirs

Originally Authorized Reservoir Plan
Modified Reservoir Plan
Small Reservoirs

BYPASS TUNNEL PLANS (22' Diameter)

Bypass Tunnel "A" with Channel Improvements Below Outlet
" Tunnel "B" " " " " "
" Tunnel "C"
" Tunnel "D"
" Tunnel "E"

CHANNEL IMPROVEMENT PLAN

Channel Improvement

COMBINATION PLANS

Phillips Lake and Channel Improvement
Phillips Lake and Concrete Lined Channel
Phillips Lake, Tunnel "A" and Channel Improvement
Phillips Lake, Tunnel "B" and Channel Improvement
Phillips Lake and Tunnel "C"

NON-STRUCTURAL

No Action or Without Project Condition
Flood Insurance and Zoning
Flood Proofing
Early Warning and Evacuation
Permanent Evacuation of the Flood Plain

STRUCTURAL
PLANS

NORTH NASHUA RIVER BASIN

ORIGINALLY AUTHORIZED RESERVOIR PLAN

PLAN DESCRIPTION

The original flood control plan, authorized by the Flood Control Act of 1966, included the construction of three upstream reservoirs and rehabilitating the North Nashua River channel through Fitchburg. One reservoir, Whitmanville Lake, would be situated on the Whitman River approximately 4,000 feet downstream of the existing Whitmanville Reservoir. The other two reservoirs, Nookagee Lake and Phillips Lake, would be located on Phillips Brook.

The following table indicates the amount of flood control storage that would be provided at each reserovir.

Reservoir	Storage (in acre-feet)
Whitmanville Lake	6,700
Nookagee Lake	4,700
Phillips Lake	1,600

ECONOMICS

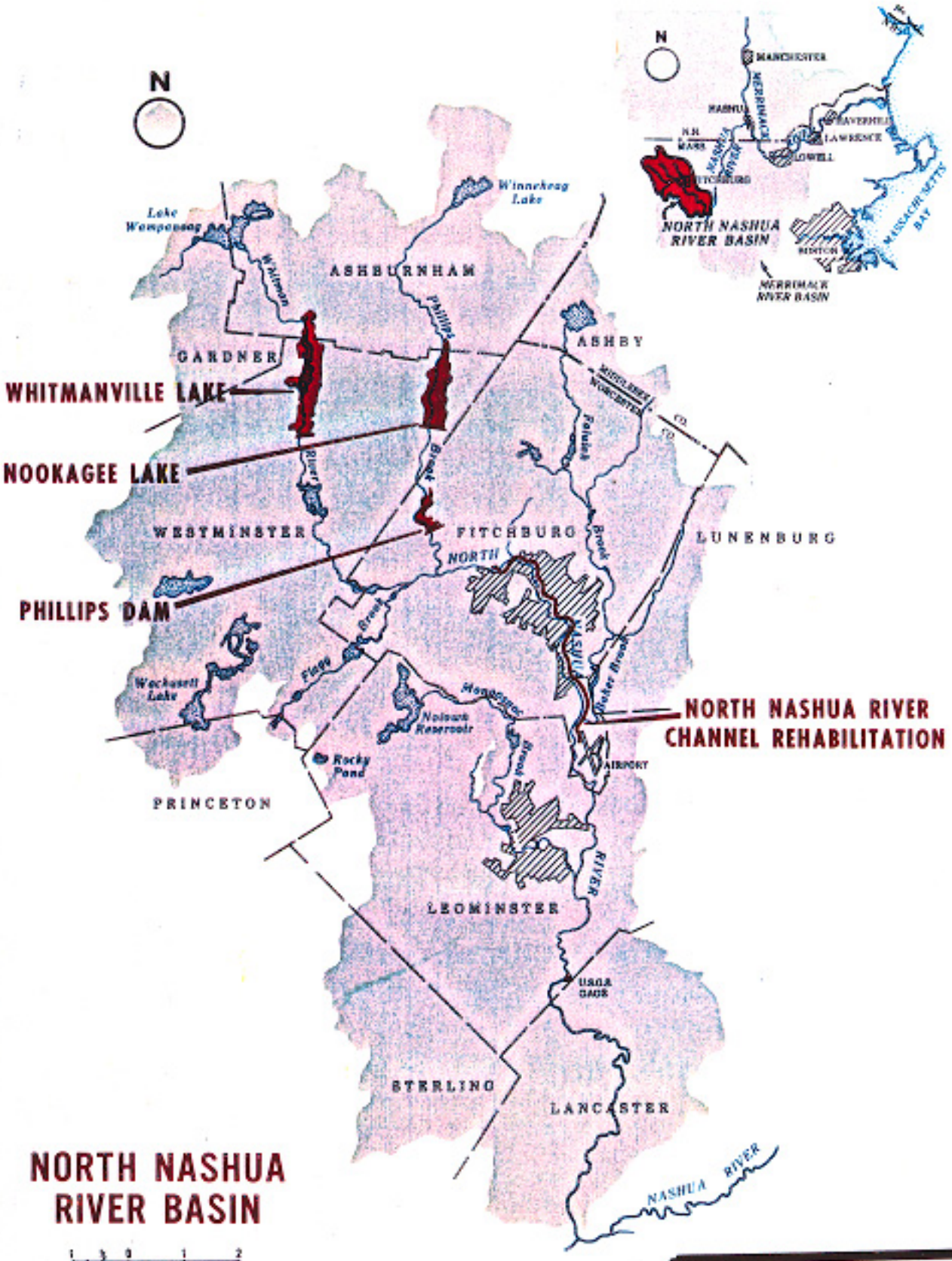
The approximate costs and benefits of this plan are as follows:

FIRST COSTS

Whitmanville Lake	$12,700,000
Nookagee Lake	16,400,000
Phillips Lake	6,900,000
Total project	$36,000,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$2,480,000
Annual Benefits	$3,400,000
B/C Ratio	1.4 to 1.0



ORIGINALLY AUTHORIZED

RESERVOIR PLAN

MODIFIED RESERVOIR PLAN

PLAN DESCRIPTION

This plan consists of two upstream flood control reservoirs and the North Nashua River channel rehabilitation. This plan is similar to the originally authorized three reservoir plan except that Nookagee Lake was eliminated and Phillips Lake was enlarged to provide adequate control over the Phillips Brook watershed. The location of both the Whitmanville and Phillips Dams remained the same. The purpose of this modification was to reduce the amount of real estate acquisition necessary for project construction. The following tabulation indicates the amount of flood control storage that would be provided at each reservoir.

Reservoir	Storage (in acre-feet)
Whitmanville Lake	6,700
Phillips Lake	5,050

ECONOMICS

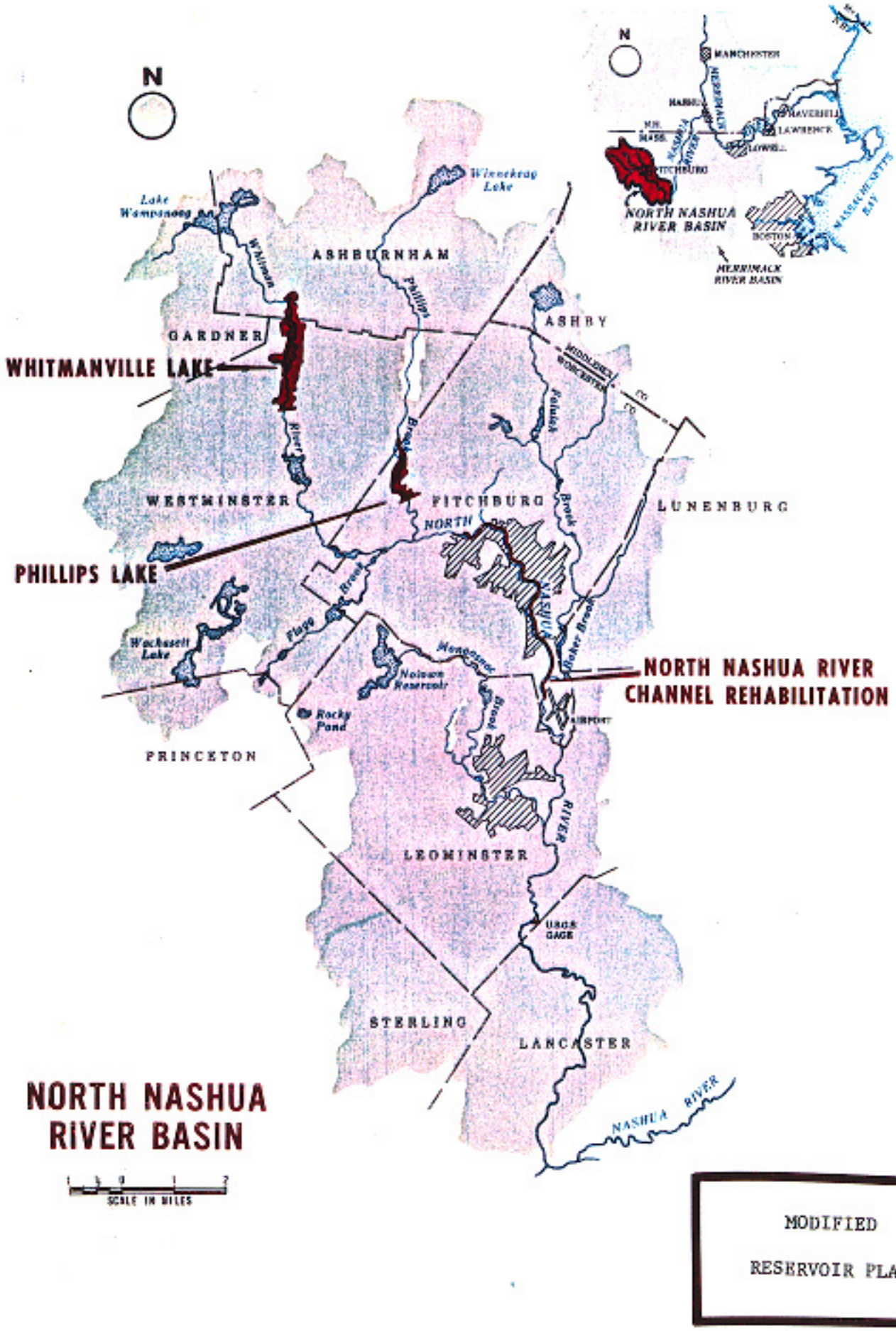
The approximate costs and benefits of this plan are as follows:

FIRST COSTS

Whitmanville Lake	$12,700,000
Phillips Lake	14,500,000
Total project	$27,200,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$1,870,000
Annual Benefits	$3,400,000
B/C Ratio	1.8 to 1.0


N
Lake Wampanoag
Winnekeag Lake
ASHBURNHAM
GARDNER
WHITMANVILLE LAKE
ASHBY
WESTMINSTER
FITCHBURG
LUNENBURG
PHILLIPS LAKE
Wachusett Lake
Rocky Pond
PRINCETON
Meadow Brook
Noiwan Reservoir
NORTH NASHUA RIVER CHANNEL REHABILITATION
AIRPORT
LEOMINSTER
USGS GAGE
STERLING
LANCASTER
NASHUA RIVER
NORTH NASHUA RIVER BASIN
SCALE IN MILES
MANCHESTER
HAVERHILL
LAWRENCE
LOWELL
FITCHBURG
NORTH NASHUA RIVER BASIN
BOSTON
MASSACHUSETTS BAY
MERRIMACK RIVER BASIN
MODIFIED
RESERVOIR PLAN

NORTH NASHUA RIVER BASIN

SMALL DAMS

PLAN DESCRIPTION

In addition to the three originally proposed dam sites, six other potential dam sites have been identified and are currently being evaluated. At the present time this evaluation is limited to estimates of construction cost and the extent of real estate acquisition necessary for construction. The effect that these dams would have on flooding in Fitchburg is currently being evaluated. When this analysis is complete, further data concerning the feasibility of these sites will be made available.

During our meeting with the Fitchburg Citizens' Advisory Committee on 23 May 1979, the Hayden, Harding and Buchanan report on alternate dam sites was also discussed. Inasmuch as a primary concern of local interests is the impact that reservoir construction would have on each site with real estate required. Utility relocations necessary and the cost of flood control structures at each site were also evaluated. The committee was informed that the resulting curves and tables comparing levels of development with these parameters will be used for the initial screening of alternate dam sites. The sites that appear acceptable will then be evaluated to determine their flood control effectiveness.

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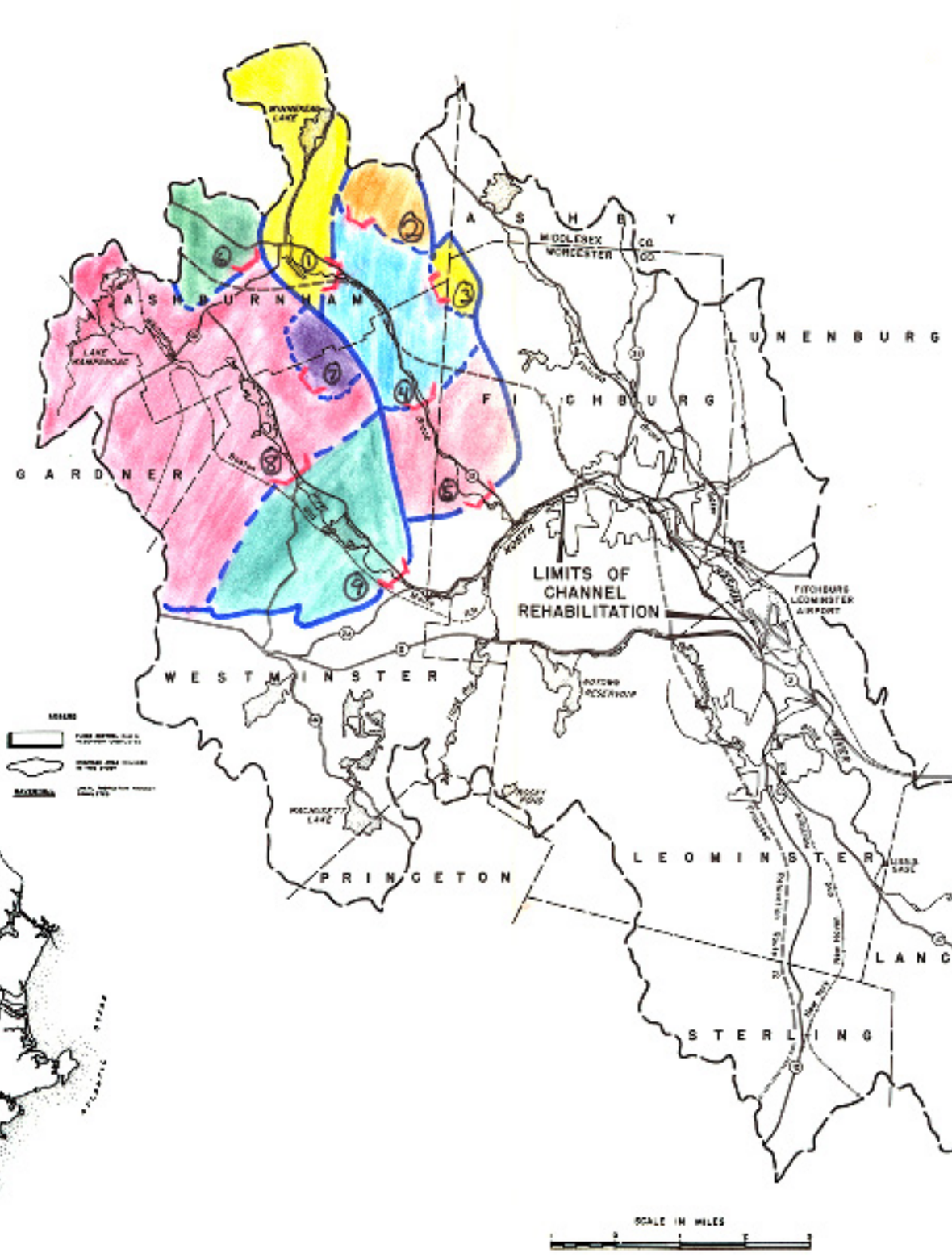
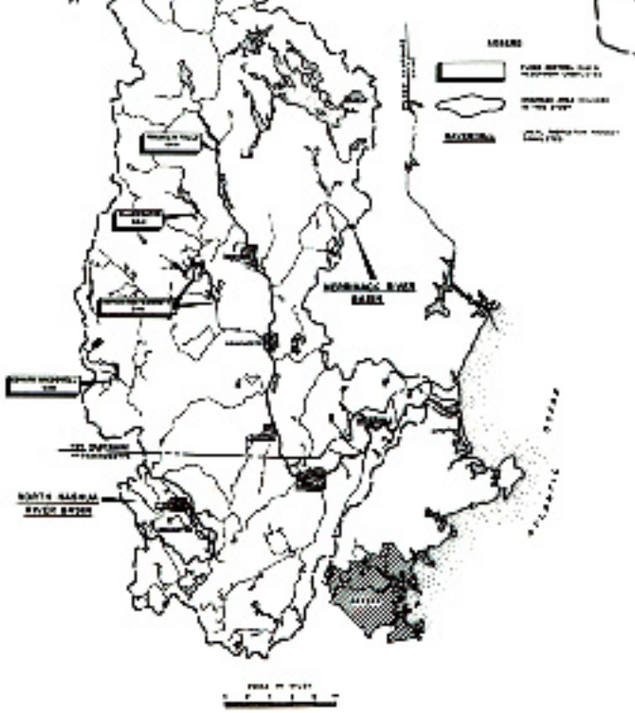
LOCATION MAP





① Factory Village
② Brown Brook
③ Laws Brook
④ NooKagee *
⑤ Phillips *
⑥ Corey Hill Road
⑦ Barrell Road
⑧ Whitmanville
⑨ Lower Crocker Pond

* Origionally Authorized Reservoirs

WATER RESOURCE DEVELOPMENT PLAN
NORTH NASHUA RIVER BASIN
NERRIMACK RIVER BASIN MASSACHUSETTS

NORTH NASHUA RIVER BASIN

BYPASS TUNNEL "A" WITH CHANNEL IMPROVEMENTS BELOW OUTLET

PLAN DESCRIPTION

This alternative includes construction of a 22-foot diameter underground bypass tunnel with appropriate surface inlet and outlet structures. The inlet would be situated just upstream of the Fitchburg Paper Company Lower Dam (approx, sta. 600+00) and the outlet would be located about 300 feet upstream of the Water Street bridge (approx. sta. 463+00). This tunnel would be approximately 9,400 feet in length. Channel improvements and bridge replacement (as necessary) extending from the outlet of the tunnel to the Fitchburg-Leominster city line, would also be included as part of this plan. The combined capacity of the underground tunnel and existing channel after rehabilitation would be capable of conveying the standard project flood.

ECONOMICS

The estimated costs and benefits of this alternative are shown in the following tabulations.

FIRST COSTS

Federal

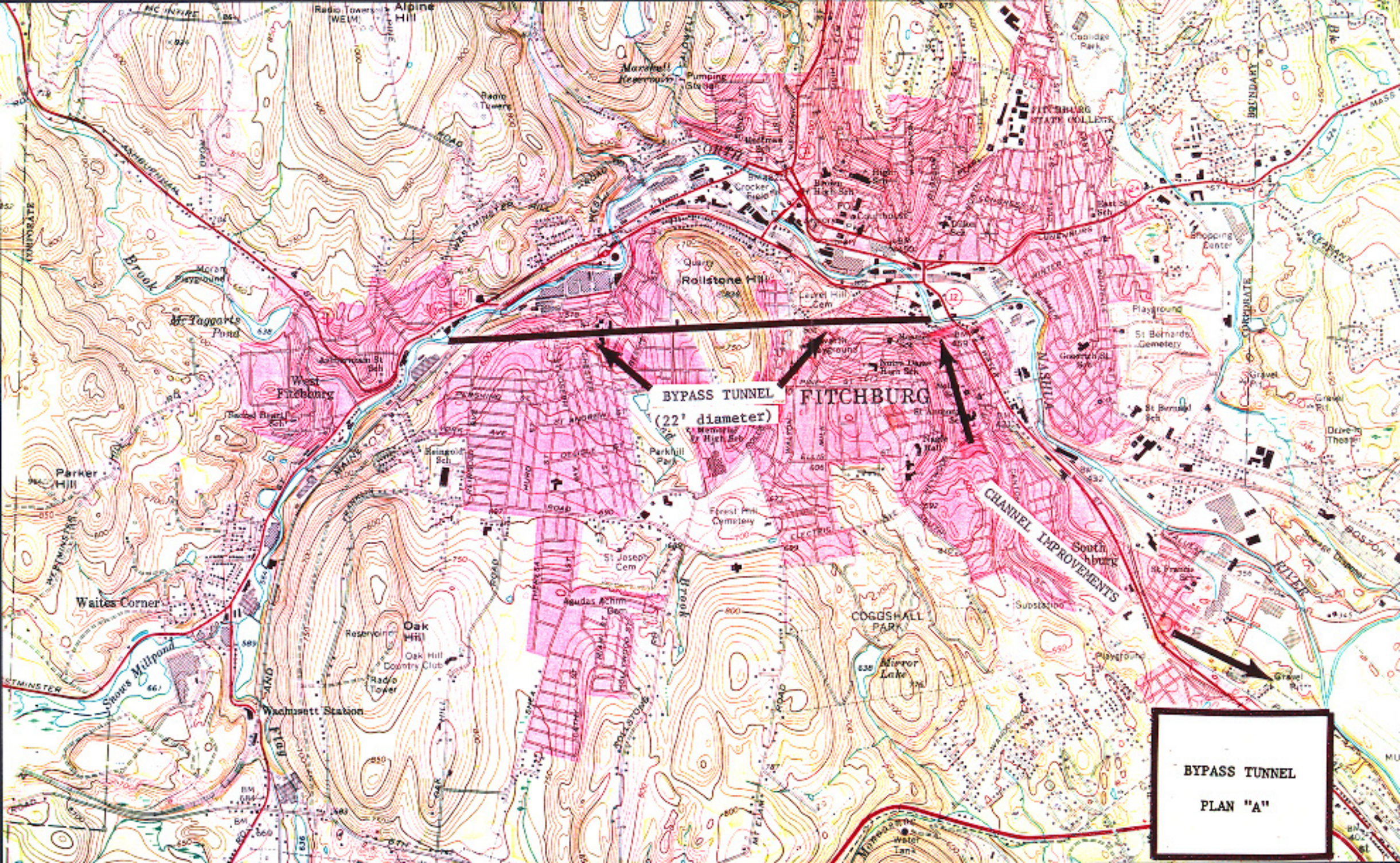
Bypass Tunnel "A"	$20,500,000
Channel Improvements	10,700,000

Non-Federal

Real Estate	$ 6,000,000
Bridge Modifications	1,900,000
TOTAL PROJECT COST	$39,100,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$2,690,000
Annual Benefits	$3,300,000
B/C Ratio	1.2 to 1.0


BYPASS TUNNEL
(22' diameter)
FITCHBURG
CHANNEL IMPROVEMENTS
BYPASS TUNNEL
PLAN "A"

NORTH NASHUA RIVER BASIN

BYPASS TUNNEL "B" WITH CHANNEL IMPROVEMENTS BELOW OUTLET

PLAN DESCRIPTION

This plan consists of a 22-foot diameter underground bypass tunnel with channel improvements below the outlet. A surface inlet would be situated just upstream of the Fitchburg Paper Company Lower Dam (approx. sta. 600+00) and the outlet would be located about 150 feet upstream of the Arden Mill Dam (approx. sta. 417+00). The tunnel would be approximately 11,600 feet in length. Channel imparovements and bridge replacement (as necessary) would extend from the outlet of the tunnel to the Fitchburg-Leominster city line. The combined capacity of the tunnel and existing channel after rehabilitation would be capable of conveying the standard project flood.

ECONOMICS

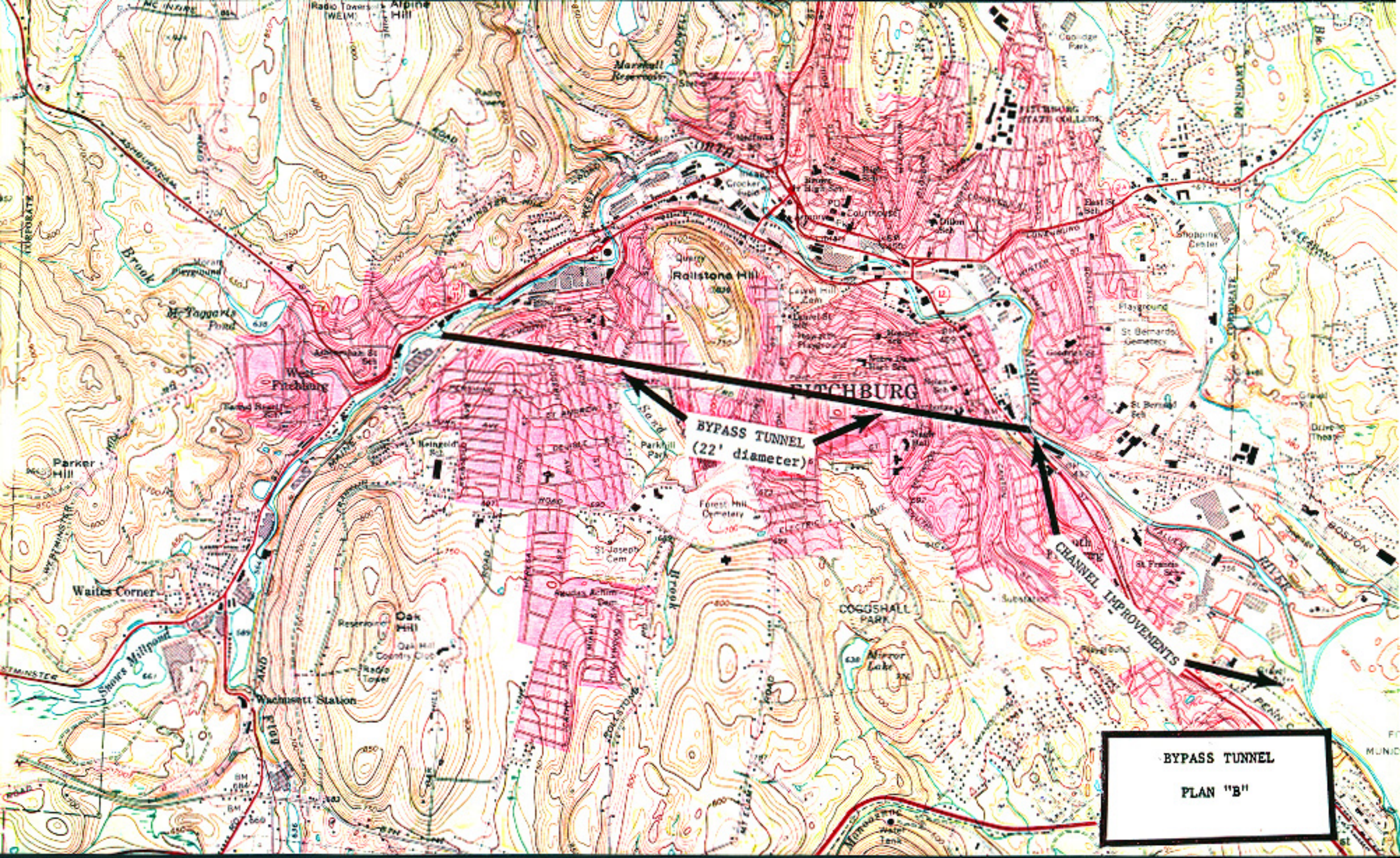
The estimated costs and benefits of this plan are shown in the following tabulations.

FIRST COSTS

Federal	
Bypass Tunnel "B"	$26,600,000
Channel Improvements	5,500,000
Non-Federal	
Real Estate	$ 2,000,000
Bridge Modifications	1,200,000
TOTAL PROJECT COST	$35,300,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$2,430,000
Annual Benefits	3,300,000
B/C Ratio	1.4 to 1.0


BYPASS TUNNEL
(22' diameter)
FITCHBURG
CHANNEL IMPROVEMENTS
BYPASS TUNNEL
PLAN "B"

NORTH NASHUA RIVER BASIN

BYPASS TUNNEL PLAN "C"

PLAN DESCRIPTION

This alternative consists of a 22-foot diameter underground bypass tunnel with appropriate surface inlet and outlet structures. The inlet would be situated just upstream of the Fitchburg Paper Company Lower Dam (approx. sta. 600+00) and the outlet would be located about 500 feet upstream from the confluence of Baker Brook and the North Nashua River (approx. sta. 420+00). The tunnel would be approximately 18,000 feet in length. The combined capacity of the tunnel and the existing North Nashua River channel after rehabilitation would convey the standard project flood.

ECONOMICS

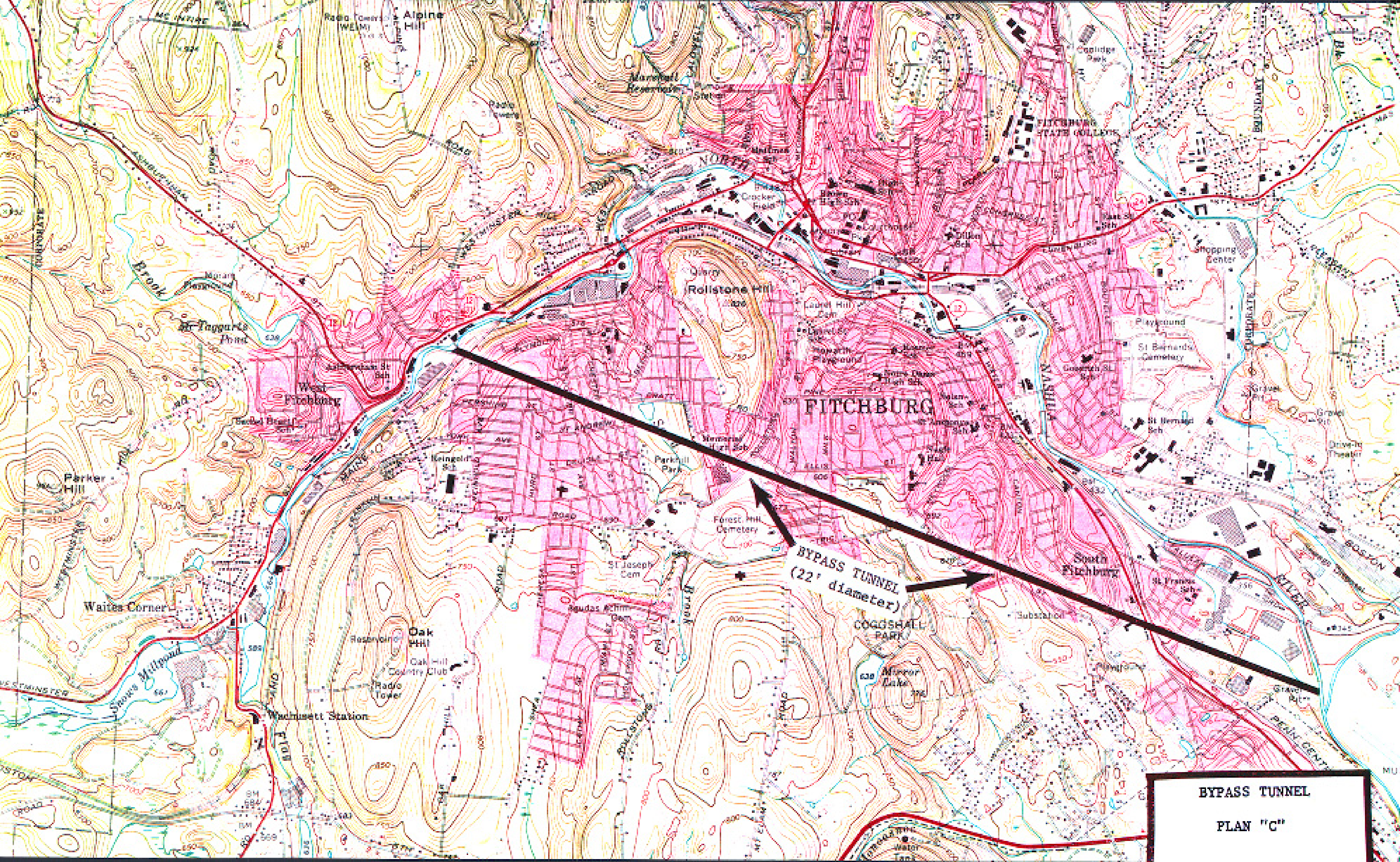
The estimated costs and benefits of this alternative are shown in the following tabulations.

FIRST COSTS

Federal	
Bypass Tunnel "C"	$36,800,000
Non-Federal	
Real Estate	600,000
TOTAL PROJECT COST	$37,400,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$2,570,000
Annual Benefits	3,300,000
B/C Ratio	1.3 to 1.0


BYPASS TUNNEL
(22' diameter)
FITCHBURG
West Fitchburg
South Fitchburg
Rollstone Hill
Parker Hill
Oak Hill
Waites Corner
Wachusett Station
Alpine Hill
Forest Hill Cemetery
COGGSHALL PARK
Mirror Lake
Parkhill Park
FITCHBURG STATE COLLEGE
Shopping Center
Playground
BYPASS TUNNEL
PLAN "C"

NORTH NASHUA RIVER BASIN

BYPASS TUNNEL PLAN "D"

PLAN DESCRIPTION

This alternative consists of a 22-foot diameter underground bypass tunnel with appropriate surface inlet and outlet structures. The inlet would be situated just upstream of the Fitchburg Paper Company Lower Dam (approx. sta. 600+00) and the outlet would be located immediately downstream of the U.S.G.S. gaging station in Leominster. The tunnel would be about 40,000 feet in length.

ECONOMICS

The total cost of this plan would be approximately $66,000,000 which includes real estate costs of about $800,000. Although flood control benefits attributable to this plan have not been computed, it does not appear that this plan would be economically justified.

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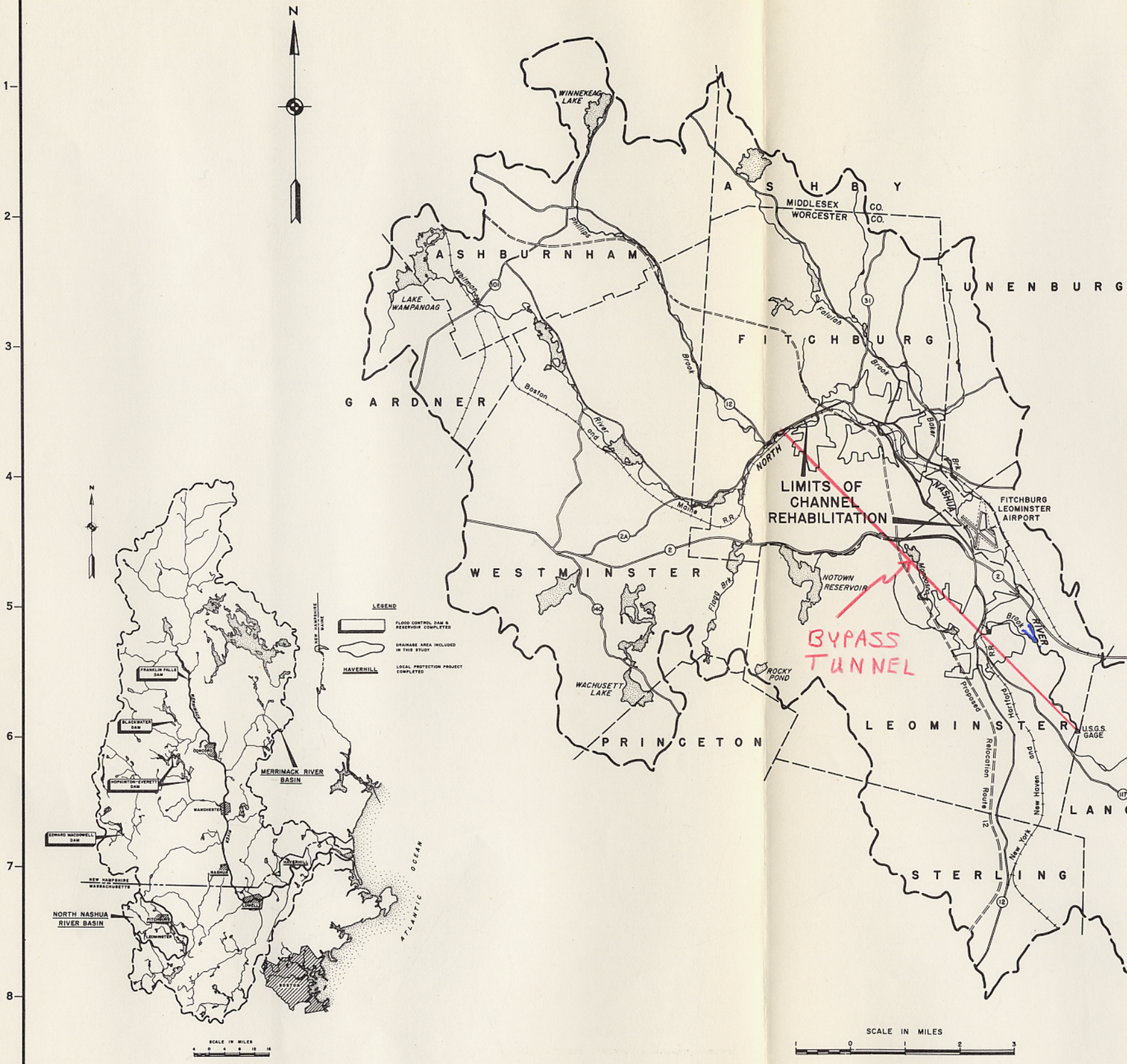

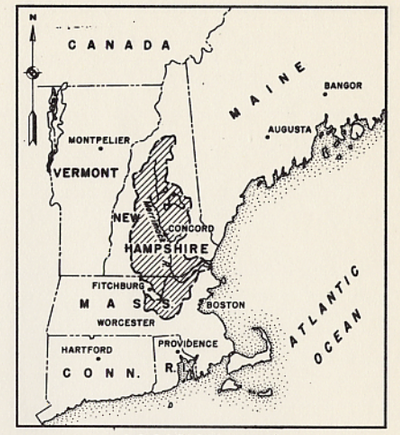

LOCATION MAP

SCALE IN MILES
25 0 25 50 75 100

WATER RESOURCE DEVELOPMENT PLAN
NORTH NASHUA RIVER BASIN
MERRIMACK RIVER BASIN MASSACHUSETTS

BYPASS TUNNEL
PLAN "D"

NORTH NASHUA RIVER BASIN

BYPASS TUNNEL PLAN "E"

PLAN DESCRIPTION

This alternative consists of a 22-foot diameter underground bypass tunnel with surface inlet and outlet structures. This plan involves the diversion of flood flows from the North Nashua River to the Nashua River. The inlet would be situated just upstream of the Fitchburg Paper Company Lower Dam and the outlet would be located on the Nashua River in Groton. The tunnel would be approximately 60,300 feet in length.

ECONOMICS

The total cost of this plan would be approximately $130,000,000 which includes real estate cost of about $1,000,000. Annual flood control benefits attributable to this plan have not been computed. However, with the high cost of this plan, it does not appear that it would be economically justified. In addition, negative social, environmental and engineering impacts associated with such a diversion would prevent further consideration of this alternative.

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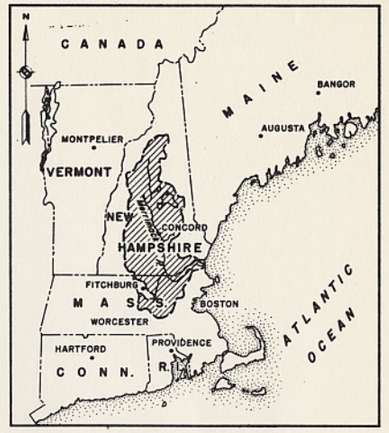
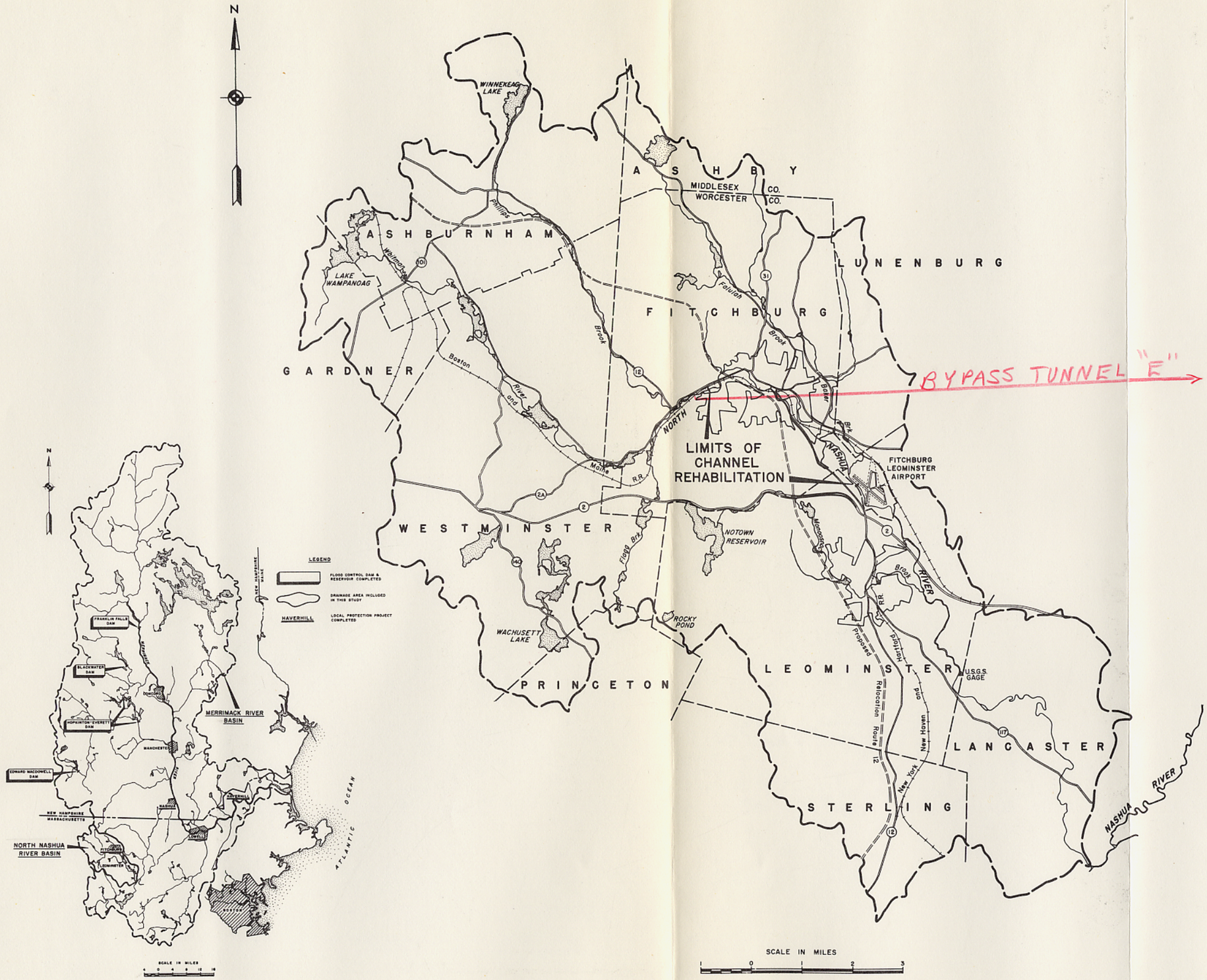


LOCATION MAP

SCALE IN MILES 25 0 25 50 75 100



SCALE IN MILES 0 1 2 3

WATER RESOURCE DEVELOPMENT PLAN
NORTH NASHUA RIVER BASIN
MERRIMACK RIVER BASIN MASSACHUSETTS

BYPASS TUNNEL PLAN "E"

NORTH NASHUA RIVER BASIN

CHANNEL IMPROVEMENT

PLAN DESCRIPTION

This plan involves increasing the size of the North Nashua River channel through the city of Fitchburg to accomodate the standard project flood.

ECONOMICS

The estimated costs and benefits of enlarging the channel are shown in the following tabulations.

FIRST COSTS

Federal

Channel Improvement	$41,200,000

Non-Federal

Real Estate	$22,800,000
Bridge Modifications	10,200,000
TOTAL PROJECT COST	$74,200,000

ANNUAL COSTS, BENEFITS, AND BENEFIT/COST RATIO

Annual Costs	$5,100,000
Annual Benefits	$3,400,000
B/C Ratio	0.7 to 1.0

NORTH NASHUA RIVER BASIN

PHILLIPS LAKE AND CHANNEL IMPROVEMENT

PLAN DESCRIPTION

This plan consists of construction of one flood control reservoir (Phillips Lake) and increasing the size of the North Nashua River channel. The storage capacity (5,500 acre-feet) and location of Phillips Lake are the same as that discussed in the Modified Reservoir Plan. Channel improvements would be sized to convey the standard project flood as modified by Phillips Lake.

ECONOMICS

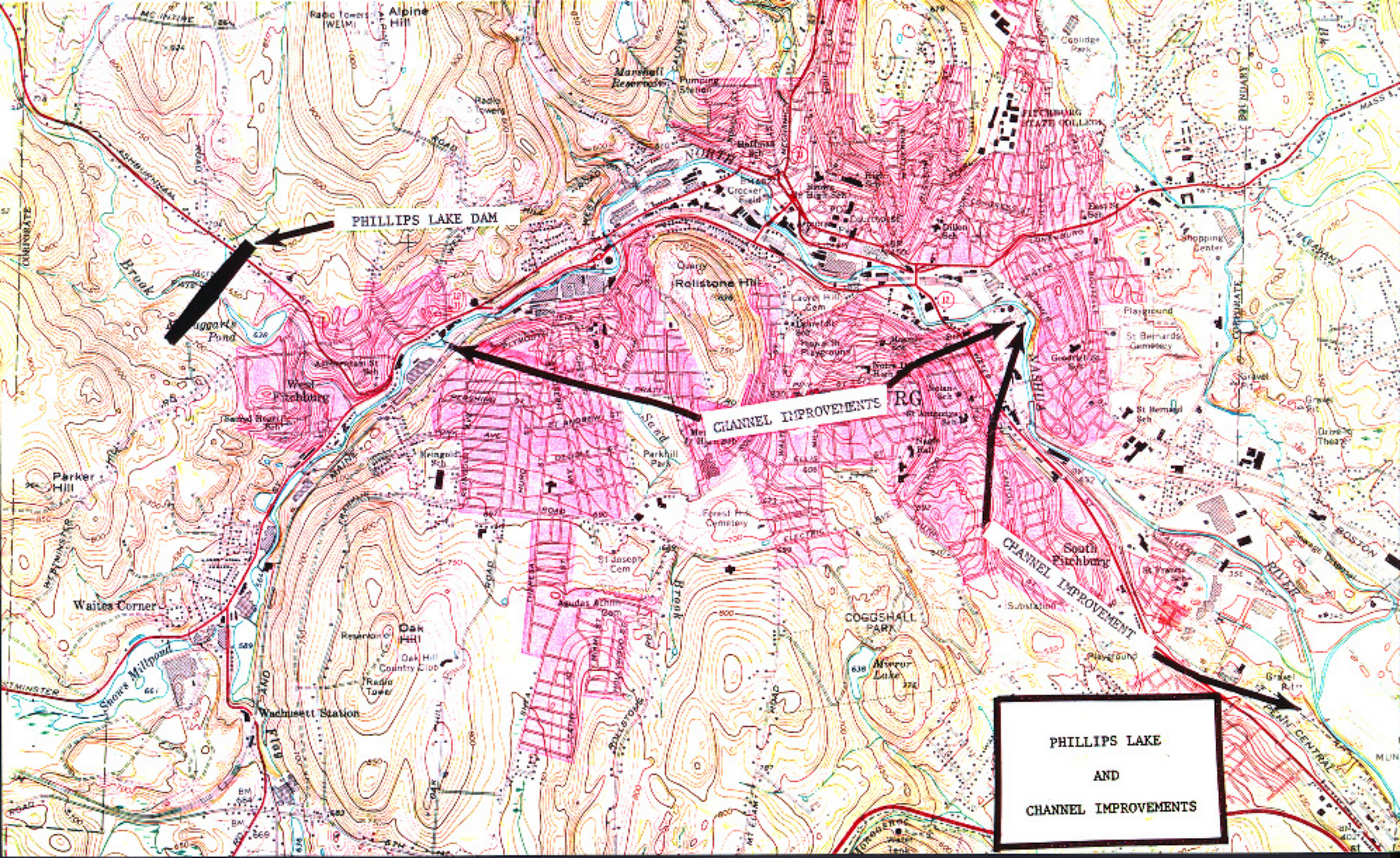
The estimated costs and benefits of this combination plan are shown in the following tabulations.

FIRST COSTS

Federal	
Phillips Lake	$14,500,000
Channel Improvements	33,500,000
Non-Federal	
Real Estate	$14,000,000
Bridge Modifications	7,600,000
TOTAL PROJECT COST	$69,600,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$4,800,000
Annual Benefits	3,240,000
B/C Ratio	0.7 to 1.0


PHILLIPS LAKE DAM
CHANNEL IMPROVEMENTS
CHANNEL IMPROVEMENT
PHILLIPS LAKE
AND
CHANNEL IMPROVEMENTS

NORTH NASHUA RIVER BASIN

PHILLIPS LAKE AND CONCRETE LINED CHANNEL

Plan Description

This plan includes the construction of Phillips Lake as presented in the Modified Reservoir and construction of a concrete lined channel from the Fitchburg Paper Company Lower Dam (Sta. 598+00) to the Fitchburg Gas and Electric Company Dam (Sta. 440+00). Also included in this plan are channel improvements below the Fitchburg Gas and Electric Company Dam.

Economics

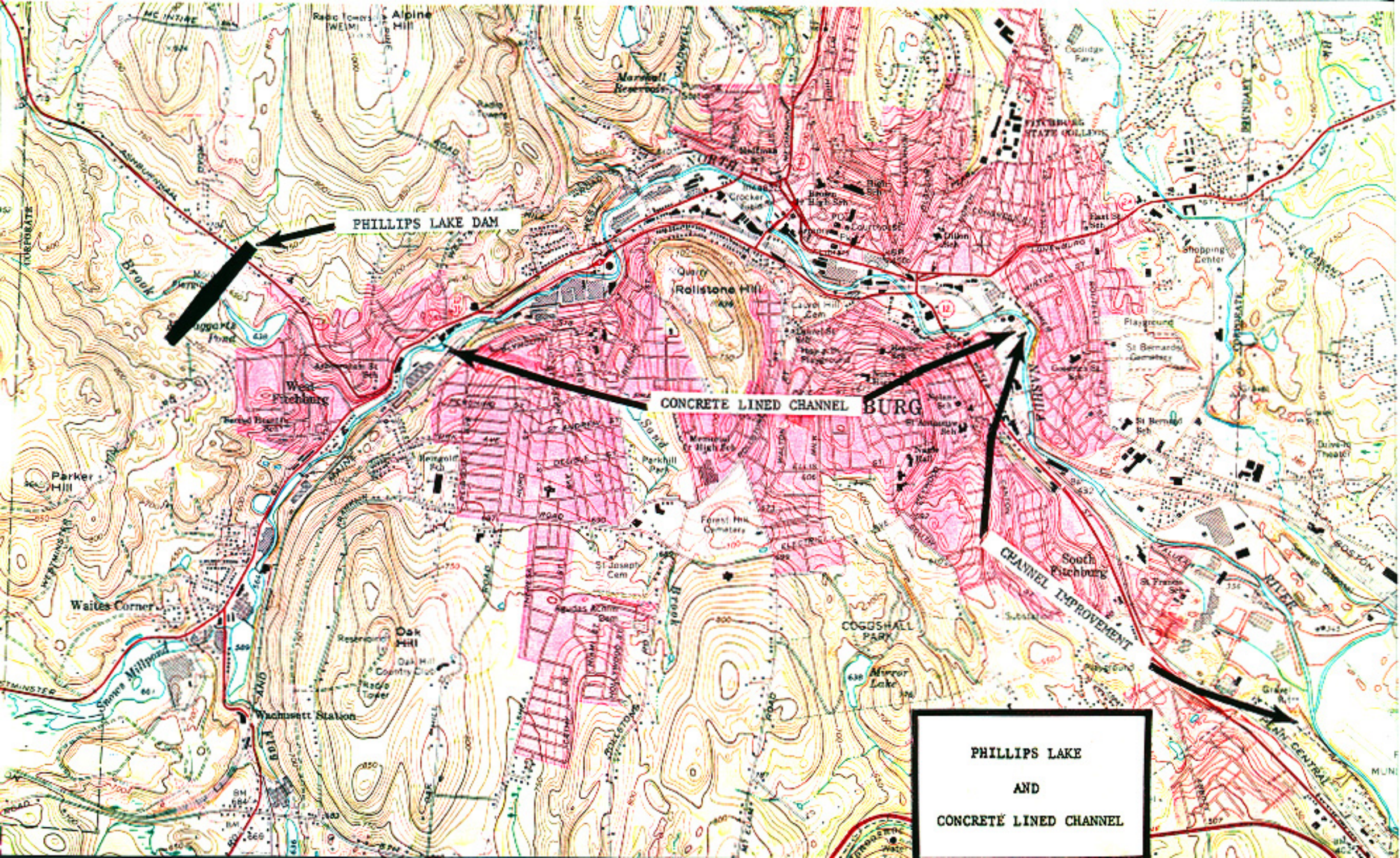
The estimated costs and benefits of this plan are shown in the following tabulations.

FIRST COSTS

Federal	
Phillips Dam	$14,500,000
Channel	42,600,000
Non-Federal	
Real Estate	$ 2,200,000
TOTAL PROJECT COST	$59,300,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Costs	$ 4,080,000
Annual Benefits	3,240,000
B/C Ratio	0.8 to 1.0


PHILLIPS LAKE DAM
CONCRETE LINED CHANNEL
CHANNEL IMPROVEMENT
PHILLIPS LAKE
AND
CONCRETE LINED CHANNEL

NORTH NASHUA RIVER BASIN

PHILLIPS LAKE, TUNNEL "A" AND
CHANNEL IMPROVEMENT

PLAN DESCRIPTION

This plan consists of construction of the following:

a) Phillips Lake, as described in the Modified Reservoir Plan

b) Bypass Tunnel "A". Inasmuch as Phillips Lake will will reduce downstream discharges the diameter of the tunnel was reduced from 22 feet to 18 feet.

c) Channel improvements, as necessary, below the outlet of the tunnel.

ECONOMICS

The costs and benefits of this alternative are presented in in the following tabulations.

FIRST COSTS

Federal

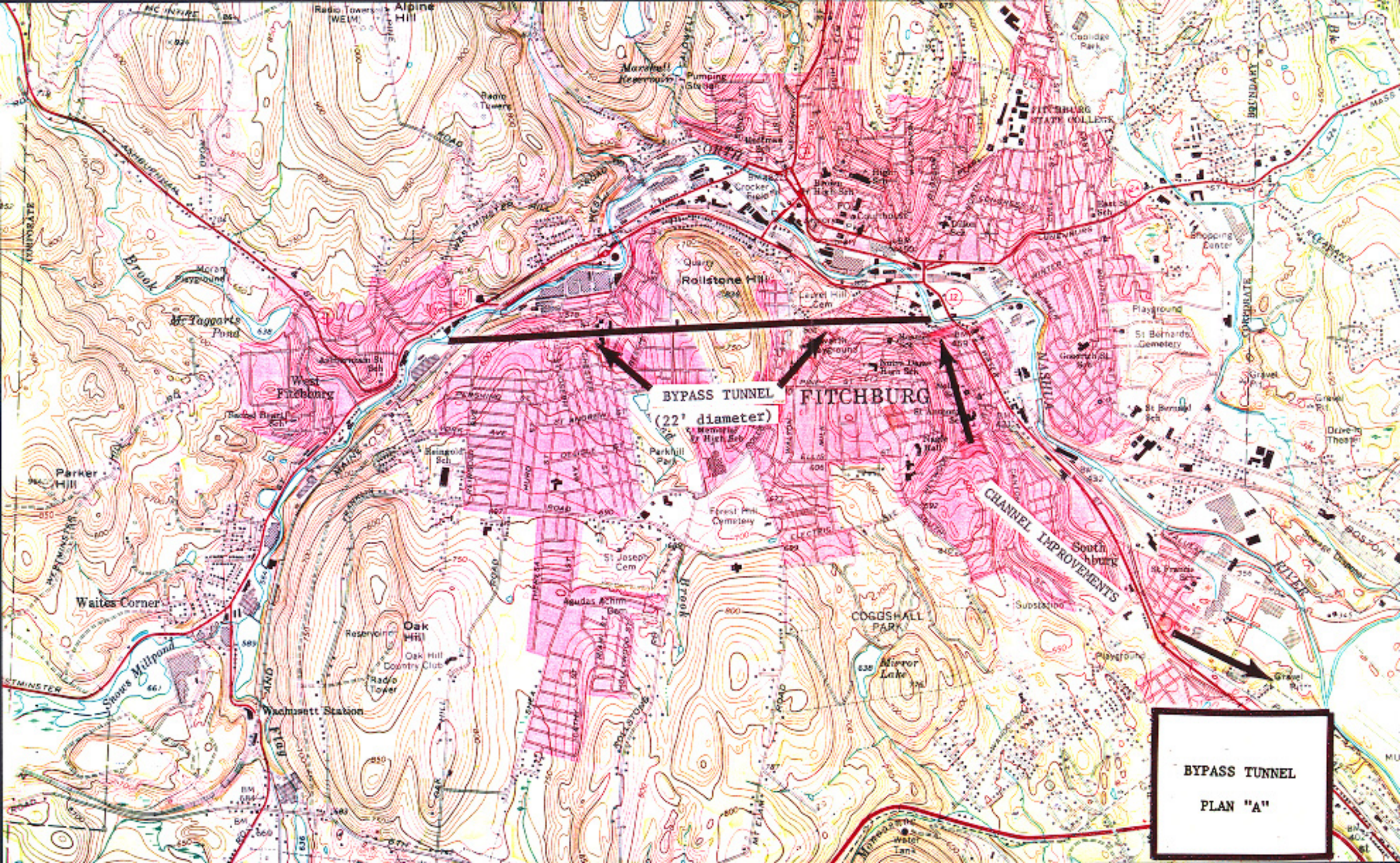
Phillips Dam	$14,500,000
Bypass Tunnel "A"	16,300,000
Channel Improvement	9,300,000

Non-Federal

Real Estate	$ 4,500,000
Bridge Modification	1,900,000
TOTAL PROJECT COST	$46,500,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Cost	$3,200,000
Annual Benefit	$3,350,000
B/C Ratio	1.05 to 1.0


BYPASS TUNNEL
(22' diameter)
FITCHBURG
CHANNEL IMPROVEMENTS
BYPASS TUNNEL
PLAN "A"

NORTH NASHUA RIVER BASIN

PHILLIPS LAKE, TUNNEL "B" AND CHANNEL IMPROVEMENT

PLAN DESCRIPTION

This plan consists of construction of the following:

a) Phillips Lake, as described in the Modified Reservoir Plan

b) Bypass Tunnel "B". Inasmuch as Phillips Lake will reduce downstream discharges the diameter of the tunnel was reduced from 22 feet to 18 feet.

c) Channel improvements, as necessary, below the outlet of the tunnel.

ECONOMICS

The costs and benefits of this alternative are presented in the following tabulations.

FIRST COSTS

Federal

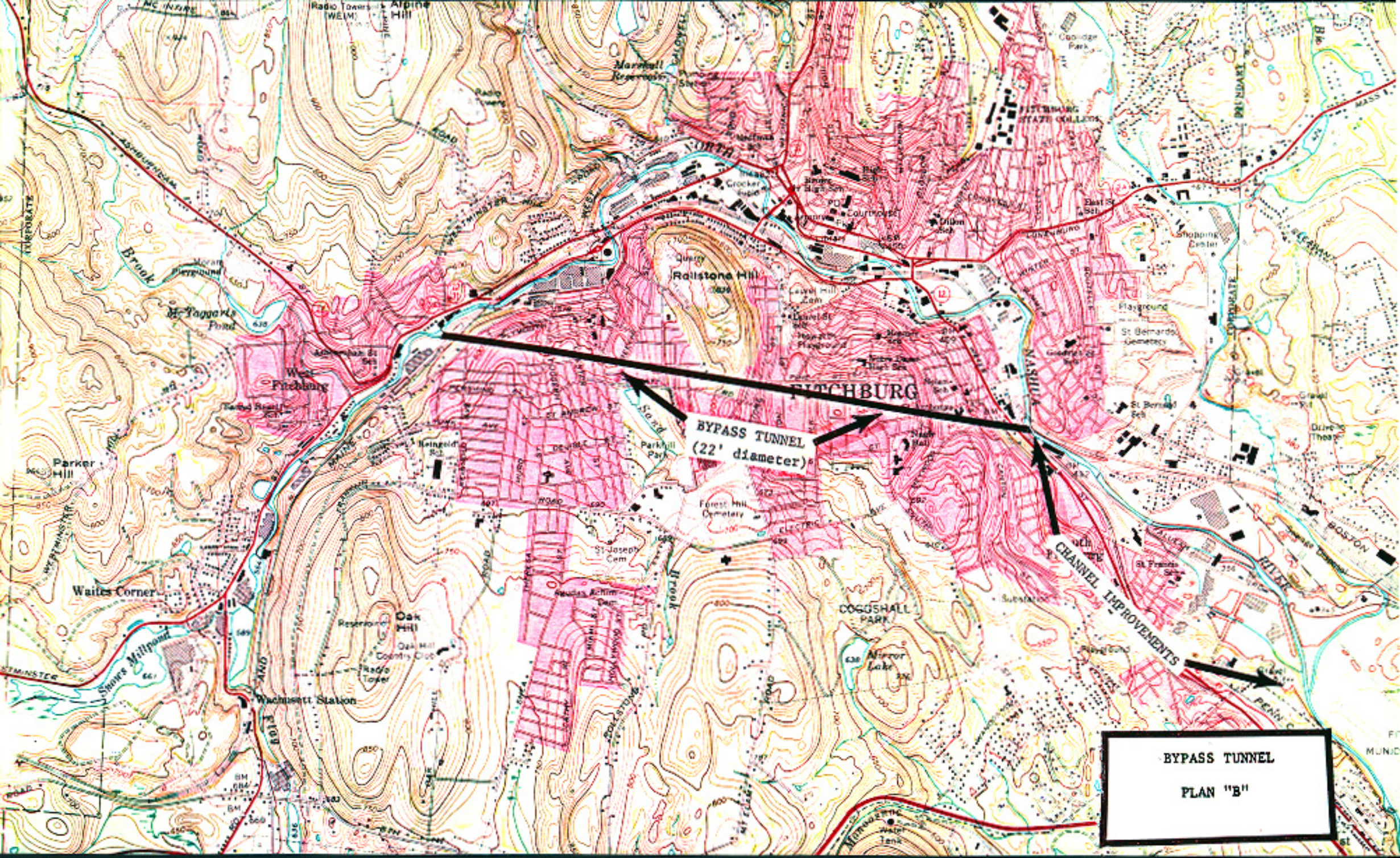
Phillips Dam	$14,500,000
Bypass Tunnel "B"	21,000,000
Channel Improvement	4,200,000

Non-Federal

Real Estate	$ 1,400,000
Bridge Modification	1,200,000
TOTAL PROJECT COST	$42,300,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Cost	$2,910,000
Annula Benefit	3,350,000
B/C Ratio	1.2 to 1.0


BYPASS TUNNEL
(22' diameter)
FITCHBURG
CHANNEL IMPROVEMENTS
BYPASS TUNNEL
PLAN "B"

NORTH NASHUA RIVER BASIN

PHILLIPS LAKE AND TUNNEL "C"

PLAN DESCRIPTION

This plan consists of construction of the following:

a) Phillips Lake, as described in the Modified Reservoir Plan

b) Bypass Tunnel "C". Inasmuch as Phillips Lake will reduce downstream discharges the diameter of the tunnel was was reduced from 22 feet to 18 feet.

ECONOMICS

The costs and benefits of this alternative are presented in in the following tabulations:

FIRST COSTS

Federal

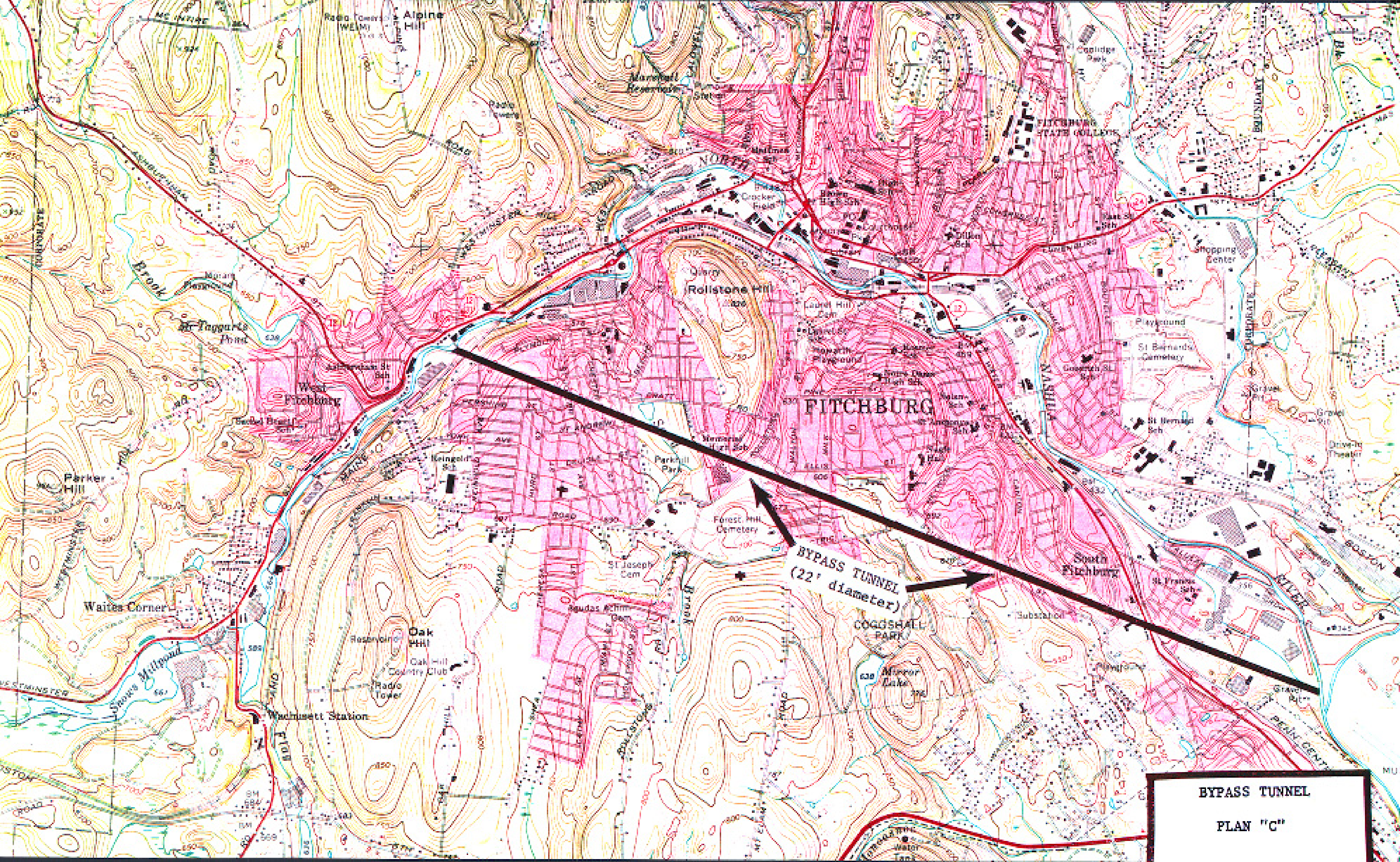
Phillips Dam	$14,500,000
Bypass Tunnel "C"	28,900,000

Non-Federal

Real Estate	$ 600,000
TOTAL PROJECT COST	$44,000,000

ANNUAL COSTS, BENEFITS AND BENEFIT/COST RATIO

Annual Cost	$3,030,000
Annual Benefit	$3,350,000
B/C Ratio	1.1 to 1.0


BYPASS TUNNEL
(22' diameter)
BYPASS TUNNEL
PLAN "C"
FITCHBURG
West Fitchburg
South Fitchburg
Rollstone Hill
Parker Hill
Oak Hill
Alpine Hill
Waites Corner
Wachusett Station
Mirror Lake
Coggshall Park
Forest Hill Cemetery
Fitchburg State College
Marshall Reservoir
Snows Millpond
McTaggarts Pond
Parkhill Park
Memorial High Sch
Shopping Center
Drive-In Theater
St Bernards Cemetery
St Joseph Cem
Oak Hill Country Club
Radio Tower
Reservoir
Substation
Playground
Quarry
Gravel Pit

NON-STRUCTURAL
PLANS

NORTH NASHUA RIVER BASIN

NO ACTION OR WITHOUT PROJECT CONDITION

This alternative does nothing to reduce the threat of future flooding. Inasmuch as there would be continued economic loss and possible loss of life due to flooding, this alternative was retained for comparative purposes only.

NORTH NASHUA RIVER BASIN

FLOOD INSURANCE AND ZONING

This plan involves participation by the community in the National Flood Insurance Program. In order to qualify for Federally subsidized flood insurance, the community must adopt flood plain zoning regulations to control further development within the flood plain. At the present time, a flood insurance study is being accomplished for the city of Fitchburg by the Department of Housing and Urban Development. When this study is completed, it is suggested that the city pass the necessary zoning by-laws so that owners of flood prone property will be able to purchase flood insurance. Although this alternative does not prevent flooding it does provide monetary reimbursement for flood losses.

NORTH NASHUA RIVER BASIN

FLOOD PROOFING

The flood proofing alternative consists of those modifications to structures and building contents which are designed to reduce flood damages. Flood proofing techniques include providing watertight closures for existing buildings, elevating structures, construction of walls or dikes around existing structures and other methods of preventing flood damage to structures and their contents.

Although numerous buildings within the flood plain would benefit from flood proofing, many structures do not lend themselves to this type of protection. The age or type of construction may preclude installation of watertight closures, or raising the structure may be impractical or too costly. It should also be noted that although this alternative would protect buildings and their contents, roadways, railroads and other public utilities would still be subject to flood damage.

Inasmuch as a structure by structure analysis would be required to determine the applicability of flood proofing, the cost of this atlernative has not been determined. However, because preliminary studies indicate that some structures cannot be flood proofed, flood insurance and zoning will be included in further studies of this alternative.

NORTH NASHUA RIVER BASIN
EARLY WARNING AND EVACUATION

The emphasis of this plan is to protect lives rather than prevent property damage. The success of this plan depends upon the cooperation of involved agencies and individuals in the planning and execution of this alternative. Although implementation of this alternative would be a local responsibility, the Corps could provide technical information at the request of local or State officials.

As the title implies, there would be two major activities of this alternative. The first phase would be the pre-flood forecast and warning action. The focus of this phase would be to monitor upstream water levels at a point such as Whitmanville Reservoir or Crocker Pond. When the water level reaches a critical stage, local officials would begin warning residents of the flood prone area.

The next phase of this plan would then be to evacuate these citizens and provide them with shelter and other emergency needs during the flood event.

Although the warning time would be relatively short, due to the rapid runoff characteristics of the North Nashua River Basin, this plan could be implemented by local officials at any time. In the absence of other flood protection measures, this plan should be considered as a "Minimum" plan to protect the lives of flood plain residents.

NORTH NASHUA RIVER BASIN

PERMANENT EVACUATION OF THE FLOOD PLAIN

This plan would involve the permanent evacuation and relocation of structures within the flood plain. However, because of the extensive development along the North Nashua River, the economic, environmental and social impacts of relocating these structures virtually rules out this alternative. In addition to removing all structures from the flood plain, it would be necessary to provide as equal amount of undeveloped land for relocation of homes and businesses.

WATER RESOURCES INVESTIGATION

NORTH NASHUA RIVER BASIN
MASSACHUSETTS

ECONOMIC SUMMARY OF PRELIMINARY ALTERNATIVES

ALTERNATIVES	Federal Cost ($1,000)	Non-Federal Cost ($1,000)	Total Cost ($1,000)	Average Annual Cost ($1,000)	Average Annual Benefits ($1,000)	Benefit/ Cost Ratio	Presidents Proposed Policy Federal Cost ($1,000)	Presidents Proposed Policy Non-Federal Cost ($1,000)
Upstream Reservoirs								
Originally Authorized Reservoir Plan	36,000		36,000	24,800	34,000	1.4 to 1.0	NC	NC
Modified Reservoir Plan	27,200		27,200	1,870	3,400	1.8 to 1.0	24,570	2,630 ← DB
Small Reservoirs								
Bypass Tunnel Plans								
Tunnel "A" with Channel Improvements Below Outlet	31,200	7,900	39,100	2,690	3,300	1.2 to 1.0	29,330	9,770
Tunnel "B" with Channel Improvements Below Outlet	32,100	3,200	35,300	2,430	3,300	1.4 to 1.0	26,480	8,820
Tunnel "C"	36,800	600	37,400	2,570	3,300	1.3 to 1.0	28,050	9,350 ⇑
Tunnel "D"	65,200	800	66,000	4,540			49,500	16,500 ← DB + ESAB + WCB
Tunnel "E"	129,000	1,000	130,000	8,950			97,500	32,500
Channel Improvement Plan								
Channel Improvement	41,200	33,000	74,200	5,100	3,400	0.7 to 1.0	NC	NC
Combination Plans								
Phillips Lake and Channel Improvement	48,000	21,600	69,600	4,800	3,240	0.7 to 1.0	NC	NC
Phillips Lake and Concrete Lined Channel	57,100	2,200	59,300	4,080	3,240	0.8 to 1.0	44,480	14,820
Phillips Lake, Tunnel "A" and Channel Improvement	40,100	6,400	46,500	3,200	3,350	1.05 to 1.0	34,880	11,620
Phillips Lake, Tunnel "B" and Channel Improvement	39,700	2,600	42,300	2,910	3,350	1.2 to 1.0	31,730	10,570
Phillips Lake and Tunnel "C"	43,400	600	44,000	3,030	3,350	1.1 to 1.0	33,000	11,000
Non-Structural Plans								
No Action or without project condition								
Flood Insurance and Zoning								
Flood Proofing								
Early Warning and Evacuation								
Permanent Evacuation of the Flood Plain								

Note: NC = (No Change - Meets President's Policy)